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(54) **Illumination arrangement for elimination of gray borders in a copying device.**

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## Description

This invention relates to an iliumination arrangement for the elimination of gray borders in a copying device. One known form of copying device comprises an illumination source for iluminating a document in an object plane, and a linear image transmitter positioned between the object plane and an imaging plane so as to transmit light reflected from the document onto the imaging plane to form a latent image of the document.

A problem common to most commercial copiers is that illumination of a document lying on a transparent platen produces a shadow along the edges of the document. This shadow area is transferred to the photoreceptor in the form of unexposed areas along the edges of the document image. Unless discharged in some manner these edge "images" are developed and result in an objectionable gray border or edge on the copy sheets.

A number of approaches to solve the foregoing problems of edge or border development have been provided: A typical solution, for copiers with standard imaging lenses, is to position the lens in the optical system so that a slight magnification, usually 1.05x, is present. This magnification setting moves the gray borders outside of the area of the copy paper. Besides the obvious problem of departing from a desired 1.00x magnification, this technique cannot be used for optical systems wherein the magnification cannot be varied from 1.00x, e.g. when using gradient index lens arrays of the type described in U.S. Patent 3,947,106 and 3,977,777 and in strip lenses of the type described in U.S. Patent 3,584,950.

Other solutions to the shadow area problem are disclosed in U.S. Patents 3,642,371; 3,788,737 and 4,118,119. These patents disclose and claim various ways of modifying the platen cover to dissipate unwanted edge charge areas. In U.S. 3,642,371, the underside of the platen cover is covered with a diffusely reflective material. U.S. 3,788,717 incorporates an electroluminescent strip in the platen cover which, when excited, provides light to expose edge areas. U.S. Patent 4,118,119 discloses a facetted reflector built into the platen cover, the reflector set at particular orientations relative to each other. These solutions are relatively costly and are limited to a specific document and paper width size.

The present invention is intended to provide a simple inexpensive device to eliminate gray borders on copy paper, particularly where the optical system magnification is restricted to 1.00x.

The illumination arrangement of the invention is characterised in claim 1.

In order to make the arrangement suitable for different document sizes, the reflective means may be slidably mounted. The reflective means may be a mirror, or a prism adapted to direct light by total internal reflection to the photoreceptor.

These two embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic end view of a copier illumination system utilizing a linear image transmitter and associated reflective element.

Figure 2 is a partial frontal view of the system of Figure 1 omitting the platen and illumination source for ease of description.

Figure 3 is a schematic end view of an illumination system which utilizes a linear image transmitter and a prism arranged according to the principles of the present invention.

Figure 4 is a partial front view of the system of Figure 1 with the platen and illumination source omitted.

Figure 5 is a schematic diagram illustrating total internal reflection of light at the prism surface into the image transmitter.

Figure 6 is a schematic diagram illustrating the positioning of the total internal reflecting surface of the prism.

Referring now to Figures 1 and 2, a transparent platen 10 having a document 12 thereon is moved in the indicated direction past optical system 14. System 14 consists of a gradient index lens array 16 which may be of the type commercially available from the Nippon Sheet Glass Company, Ltd. and produced under the trade name Selfoc. Apertured lamp 18 and cylindrical Fresnel reflector 20 cooperate to produce an intense narrow band of illumination during scanning.

An optical path 22 extends from the platen through lens array 16 to the surface of a drum photoreceptor 24. According to a first aspect of the invention, reflective elements 26 are attached to the sides and at both ends of array 16. The elements are bent so as to form edges 26a which extend across the entire width of the array. The surface of the element facing the light source comprises a diffuse or specular reflective material or is coated with such a material. Edges 26a extend slightly into the imaged area as described in further detail below.

In operation, document 12 is moved through the illumination zone resulting in successive strips of the document being scanned. The light pattern reflected from the document is transmitted by array 16 to the surface of the photoreceptor 24 which rotates in synchronism with the rate at which the platen 10 is moved. Reflective elements 26 reflect a concentrated segment of light emanating from lamp 18 onto the portion of photoreceptor 24 lying beneath the element dissipating the charge on these areas. In a preferred embodiment, as shown in Figure 2, the area of charge dissipation on the photoreceptor surface is shown as segments 30 while the imaged portion is shown as 31. Elements 26 are of sufficient width and are so positioned that the concentrated area of reflected light extends into the latent image area on the drum by approximately two millimeters.

This 2 mm deleted area will usually correspond to a white area on the document and therefore will not entail any loss of information.

The reflective elements may also present a diffusely reflective surface to lamp 18 thereby becoming, in effect, the source.

The location of elements 26 may be adjusted in either direction along the length of the lens array for example by being slidably mounted, to accommodate documents of varying size.

Referring now to Figures 3 and 4, according to a second aspect of the present invention, a prism 36 replaces the reflective tabs of the Figure 1 and 2 embodiment. The prism is adapted to direct a portion of the light from lamp 18, via total internal reflection, along one of the prism surfaces and into the field of view of lens array 16.

In operation, document 12 is moved through the illumination zone resulting in successive strips of the document being scanned. The light pattern reflected from the documents is transmitted by array 16 to the surface of photoreceptor 24 which rotates in synchronism with the rate at which the platen 10 is moved. Prism 36 directs a segment of light emanating from lamp 18 onto the portion of photoreceptor 24 lying beneath the prism dissipating the charge in this area. As shown in Figure 4, the area of charge dissipation on the photoreceptor surface is shown as segment 30 while the imaged portion is shown as 31. In this embodiment, the document has been intentionally misregistered along its edge (left side of Figure 4) so that the left edge gray border is formed within the area 30 and is simultaneously dissipated. The border from the opposite non-registered side of the document is thus made to fall outside the image area. As a result, gray borders are eliminated for any size document without need for more than one prism and without any further lateral movement of the prism.

The prism, in order to provide optimum erase energy, must have a certain critical location and possess a certain critical length. Figure 5, showing the lamp-prism-lens array in enlarged form, serves to illustrate these requirements. As shown in Figure 5, the prism is arranged so that face 36a is at such an angle that light rays emanating from aperture 18a are totally internally reflected at the surface and enter field of view 16a of lens array 16. In order for the light to be totally internally reflected at surface 36a, the light must be incident along the length of surface 36a at an angle greater than the critical angle. As an example, assume that the light from lamp 18 follows three paths as shown with principal ray A. Further, assume that the light is travelling through air and that the prism is of a glass construction. The principal ray will be refracted at surface 36b and be incident on surface 36a at angle $\theta$.

Figure 6 illustrates principal ray A incident upon surface 36a located in the position shown in Figure 5 and in a second, dotted position 36a'. Principal ray A is incident on surface 36a' at an angle $\theta'$. The ray is refracted from surface 36a' at an angle $\Phi$ in accordance with Snells law

$$n \sin \theta' = n' \sin \Phi \quad (1)$$

If $n' = 1$ (index of air) and $n = 1{,}5$ (index of glass) equation (1) can be rewritten as

$$\theta' = \sin^{-1} \frac{\sin \Phi'}{1{,}5} \quad (2)$$

As surface 36a' is rotated in a counter clockwise direction about its center point, the incidence angle $\theta'$ is effectively increased and, from equation (1), refraction angle $\Phi'$ also increases. There is some incidence angle $\theta'$ at which $\Phi = 90°$ and this angle is defined as the critical angle.

For incidence angles greater than this critical angle, the ray will be reflected rather than refracted.

Solving for the critical angle in equation (2'), $\theta = 41{,}8°$. Thus, all light rays striking surface 36a at an angle greater than 41,8°, will be totally internally reflected towards the field of view of lens 16. Referring again to Figure 5, prism 36 should be so located that the incidence angles $\alpha$, $\theta$ and $\beta$ are all larger than the critical angle; i.e. all greater than 41,8°.

Another requirement for the prism to operate effectively is that surface 36a must have a sufficient length so that light fills the entire field of view area 16a.

The above description has not discussed in detail the effect of refraction at the other two surfaces of the prism. While these effects must be considered in order to ensure accurate direction of the light into the lens array field of view, the design requirements are easily satisfied by those skilled in the art.

From the above description it is evident that the prism is optically coupling light from the light source onto the borders of a photoreceptor image plane.

In conclusion, it may be seen that there has been disclosed an improved optical imaging system. The exemplary embodiments described herein are presently preferred, however, it is contemplated that further variations and modifications within the purview of those skilled in the art can be made herein. For the prism embodiment, although only a single prism has been shown employed, some systems may require prisms at both end locations.

## Claims

1. An illumination arrangement for a copying device comprising:

an illumination source (18) for illuminating a document (12) in an object plane,

means for implementing a scan function by providing relative motion between said illumination source and said object plane

a linear lens (16) comprising a gradient index leans array positioned between said object plane

and a photosensitive image plane (24) and adapted to project light reflected from said document during said scan function onto said image plane to form latent image (31) of the document characterised by

at least one reflective element (26) positioned above, and in the field of view, of one end of the lens, said refelective element having a reflective surface (26a) for reflecting light from the illumination source throught the array end onto the photosensitive plane to discharge at least one side edge margin (30) of the latent image.

2. The illumination arrangement of claim 1 wherein said light reflected from said reflective means extends into said latent image formed on the imaging piane a distance of approximately two millimeters.

3. The illumination arrangement of claim 1 or claim 2 wherein said reflective means are slidably mounted to permit movement to new locations.

4. The illumination arrangement of any one of claims 1 to 3 wherein said reflective means present a specularly reflective surface to said illumination source.

5. The illumination arrangement of any one of claims 1 to 3 wherein said reflective means present a diffusely reflective surface to said illumination source.

6. The illumination arrangement of claim 1 wherein said reflective means includes at least one prism (36) located between said object plane 4 and said linear lens (16), said prism reflecting a portion of the illumination by total internal reflection, into the entrance aperture at an end portion of said linear lens (16).

7. The illumination arrangement of claim 6, wherein the total internal reflection of said prism face has a length sufficient so that rays reflected therefrom completely fill the entrance aperture end portion of said linear lens (16).

8. The illumination arrangement of claim 7, wherein two prisms are located between said object plane and said linear lens (16), said prisms each reflecting light into opposite end portions of the entrance aperture of said linear lens (16).

**Patentansprüche**

1. Beleuchtungsanordnung für eine Kopiervorrichtung mit einer Beleuchtungsquelle (18) zum Beleuchten eines Schriftstückes (12) in einer Objektebene, einer Einrichtung zum Durchführen einer Abtastfunktion durch Bereitstellung einer Relativbewegung zwischen der genannten Beleuchtungsquelle und der genannten Objektebene, einer linearen Linse (16) mit einer Gradienten-Index-Linsenanordnung, die zwischen der genannten Objektebene und einer lichtempfindlichen Bildebene (24) angeordnet und eingerichtet ist, vom genannten Schriftstück reflektiertes Licht während der genannten Abtastfunktion auf die genannte Bildebene zu projizieren, um ein latentes Bild (31) des Schriftstückes zu formen, gekennzeichnet durch wenigstens ein Reflexionselement (26), das oberhalb und im Gesichtsfeld eines Endes der Linse angeordnet ist, welches genannte Reflexionselement eine Reflexionsfläche (26a) aufweist zur Reflexion von Licht von der Beleuchtungsquelle durch das Ende der Anordnung auf die lichtempfindliche Ebene, um wenigstens einen Seitenrand (30) des latenten Bildes zu entladen.

2. Beleuchtungsanordnung nach Anspruch 1, in welcher das von der genannten Reflexionseinrichtung reflektierte Licht um eine Strecke von ungefähr 2 mm in das in der Bildebene geformte latente Bild hineinreicht.

3. Beleuchtungsanordnung nach Anspruch 1 oder 2, in welcher die genannte Reflexionseinrichtung verschiebbar angeordnet ist, um Bewegungen zu anderen Stellen hin zu ermöglichen.

4. Beleuchtungsanordnung nach irgendeinem der Ansprüche 1 bis 3, in welcher die genannte Reflexionseinrichtung eine der genannten Beleuchtungsquelle zugewandte spiegelnd reflektierende Fläche aufweist.

5. Beleuchtungsanordnung nach irgendeinem der Ansprüche 1 bis 3, in welcher die genannte Reflexionseinrichtung eine der genannten Beleuchtungsquelle zugewandte diffus reflektierende Fläche aufweist.

6. Beleuchtungsanordnung nach Anspruch 1, in welcher die genannte Reflexionseinrichtung wenigstens ein zwischen der genannten Objektebene und der genannten linearen Linse (16) angeordnetes Prisma (36) aufweist, welches einen Teil des Lichtes durch innere Totalreflexion in die Einlaßöffnung an einem Endabschnitt der genannten linearen Linse (16) hinein reflektiert.

7. Beleuchtungsanordnung nach Anspruch 6, in welcher die innere Totalreflexion der genannten Prismenfläche eine Länge aufweist, die ausreichend dafür ist, daß die von ihr reflektierten Strahlen den Einlaßöffnungsendabschnitt der genannten linearen Linse (16) vollständig ausfüllen.

8. Beleuchtungsanordnung nach Anspruch 7, in welcher zwei Prismen zwischen der genannten Objektebene und der genannten linearen Linse (16) angeordnet sind, welche Prismen jeweils Licht auf gegenüberliegende Endabshnitte der Einlaßöffnung der genannten linearen Linse (16) reflektieren.

**Revendications**

1. Agencement d'éclairage pour un dispositif de reproduction comprenant:

- une source d'éclairage (18) pour éclairer un document (12) dans un plan-objet;
- un moyen pour mettre en oeuvre une fonction de balayage en fournissant un mouvement relatif entre la source d'éclairage et le plan-objet;
- une lentille linéaire (16) comprenant un

arrangement de lentille à indice à gradient placé entre le plan-objet et un plan-image photosensible (24) destiné à projeter la lumière réfléchie par le document pendant la fonction de balayage sur le plan-image de manière à former une image latente (31) du document, caractérisé par:

- au moins un élément réfléchissant (26) placé au-dessus, et dans le champ de vision, d'une extrémité de la lentille, l'élément réfléchissant ayant une surface réfléchissante (26a) pour réfléchir la lumière provenant de la source d'éclairage par l'intermédiaire de l'extrémité de l'agencement sur le plan photosensible afin de décharger au moins une marge (30) du bord latéral de l'image latente.

2. Agencement d'éclairage selon la revendication 1, dans lequel la lumière réfléchie par le moyen réfléchissant s'étend jusque dans l'image latente formée sur le plan d'imagerie suivant une distance d'environ 2 millimètres.

3. Agencement d'éclairage selon la revendication 1 ou la revendication 2, dans lequel le moyen réfléchissant est monté en coulissement de manière à permettre le mouvement jusqu'à de nouveaux emplacements.

4. Agencement d'éclairage selon l'une quelconque des revendications 1 à 3, dans lequel le moyen réfléchissant présente une surface réfléchissante spéculaire pour la source d'éclairage.

5. Agencement d'éclairage selon l'une quelconque des revendications 1 à 3, dans lequel le moyen réfléchissant présente une surface réfléchissant de façon diffuse pour la source d'éclairage.

6. Agencement d'éclairage selon la revendication 1, dans lequel le moyen réfléchissant comprend au moins un prisme (36) placé entre le plan-objet et la lentille linéaire (16), le prisme réfléchissant une partie de l'éclairage par réflexion interne totale dans l'ouverture d'entrée à une partie d'extrémité de la lentille linéaire (16).

7. Agencement d'éclairage selon la revendication 6, dans lequel la réflexion totale interne de la face du prisme a une longueur suffisante pour que les rayons réfléchis par celle-ci remplissent complètement la partie d'extrémité de l'ouverture d'entrée de la lentille linéaire (16).

8. Agencement d'éclairage selon la revendication 7, dans lequel deux prismes sont situés entre le plan- objet et la lentille linéaire (16), les prismes réfléchissant chacun la lumière dans des parties d'extrémité opposées de l'ouverture d'entrée de la lentille linéaire (16).

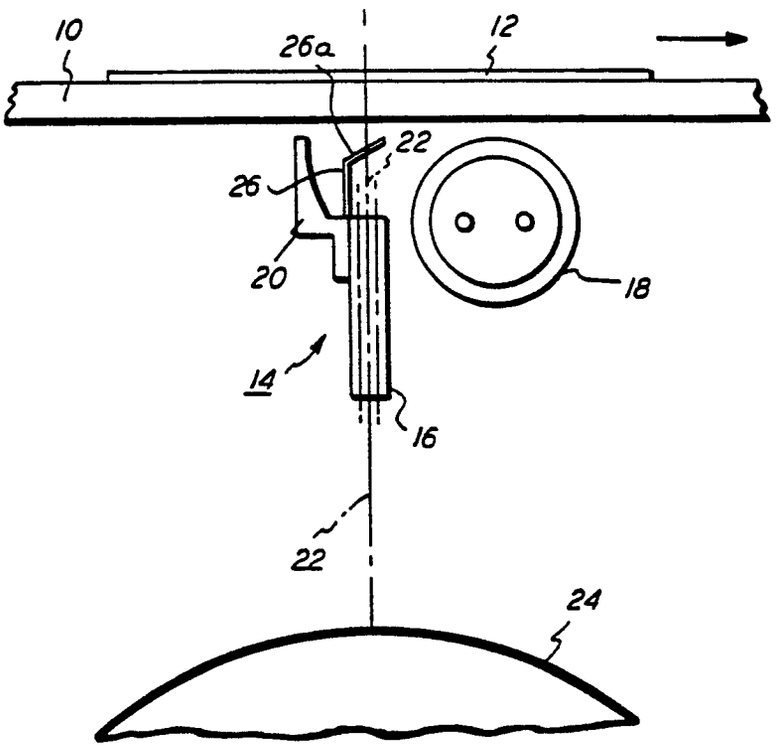



FIG. 1

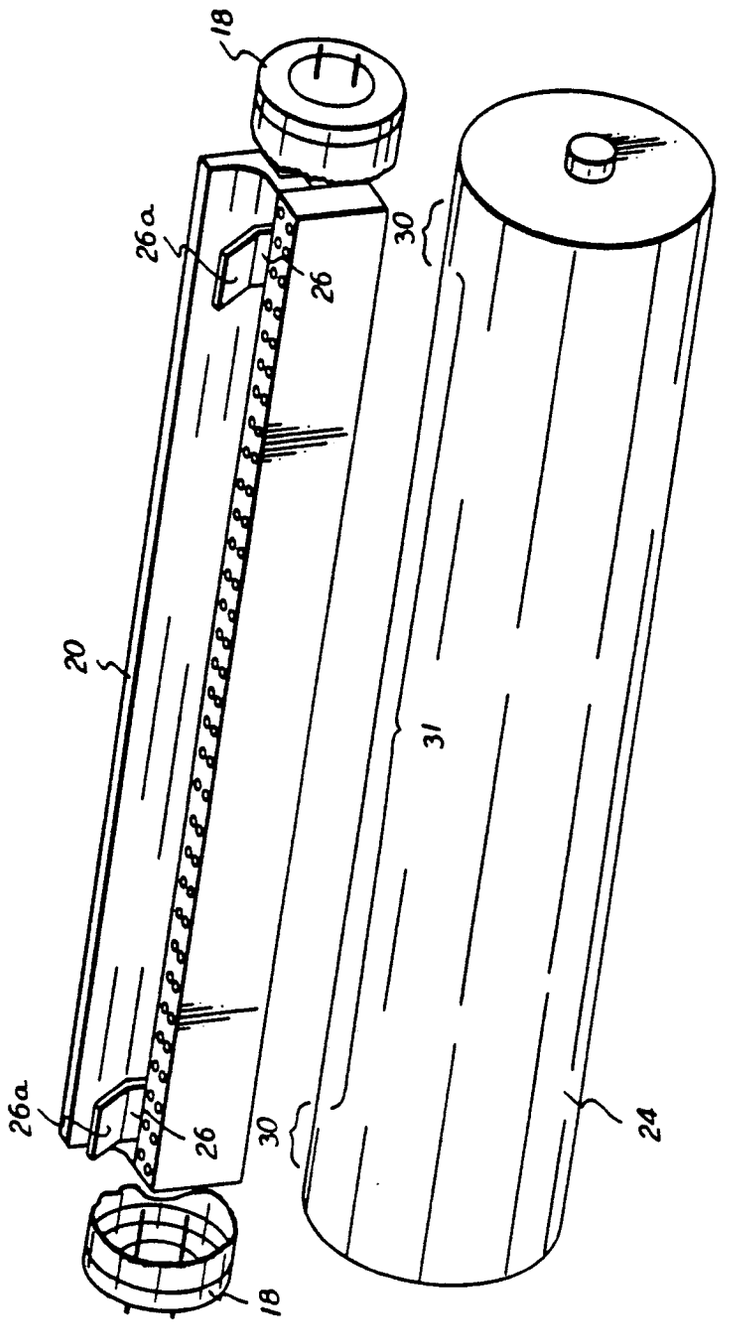



FIG. 2

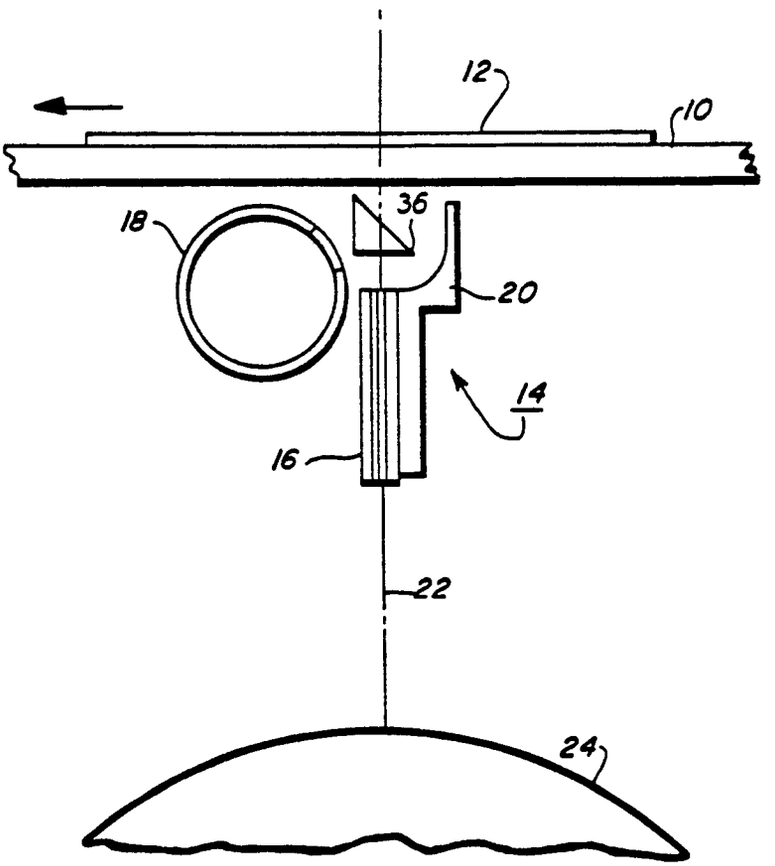



FIG. 3

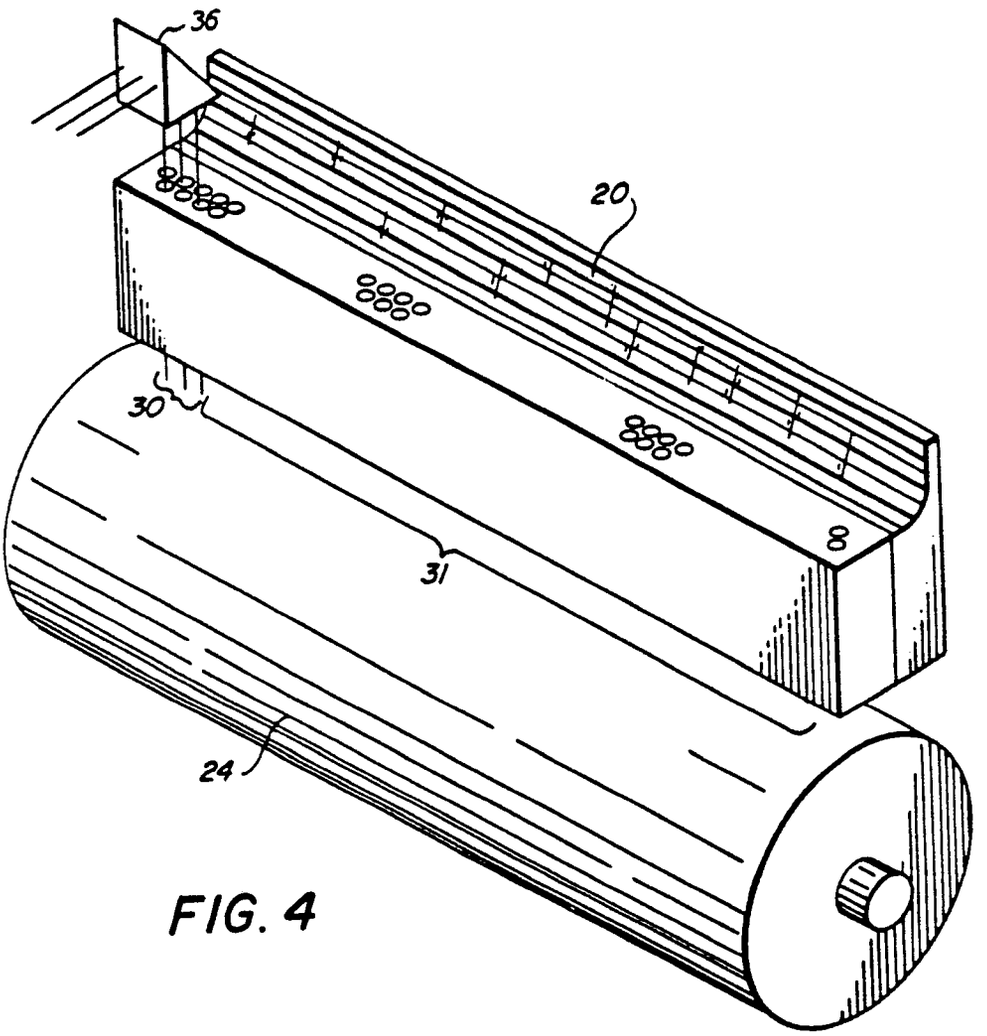



FIG. 4

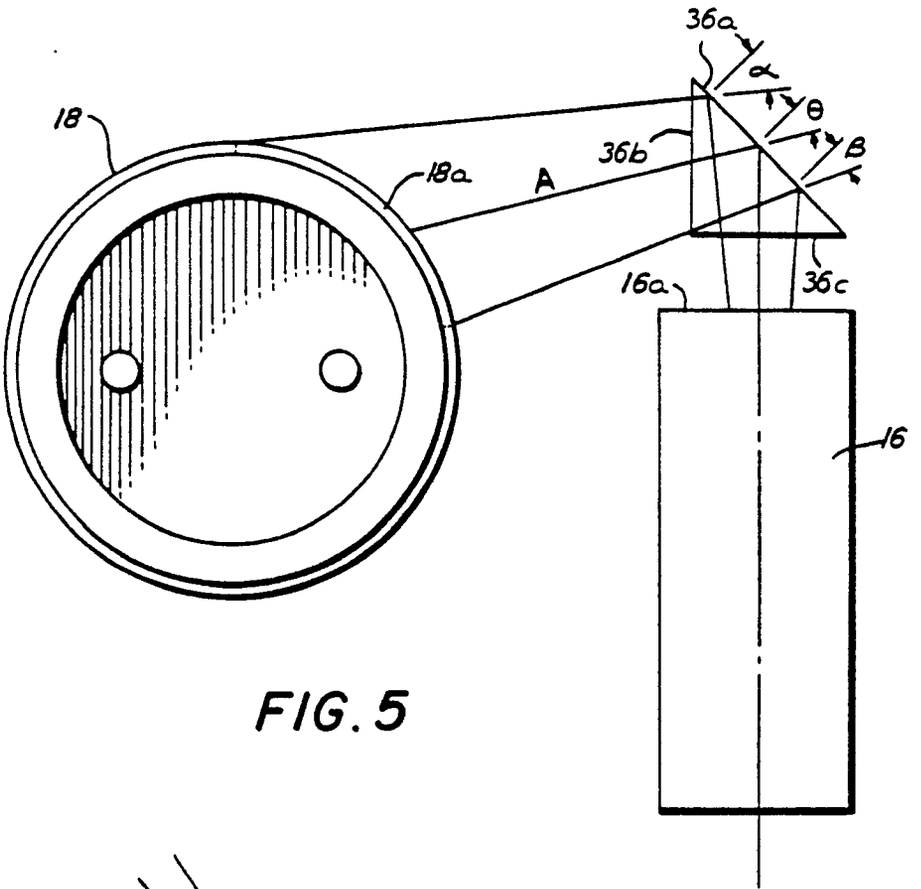



FIG. 5

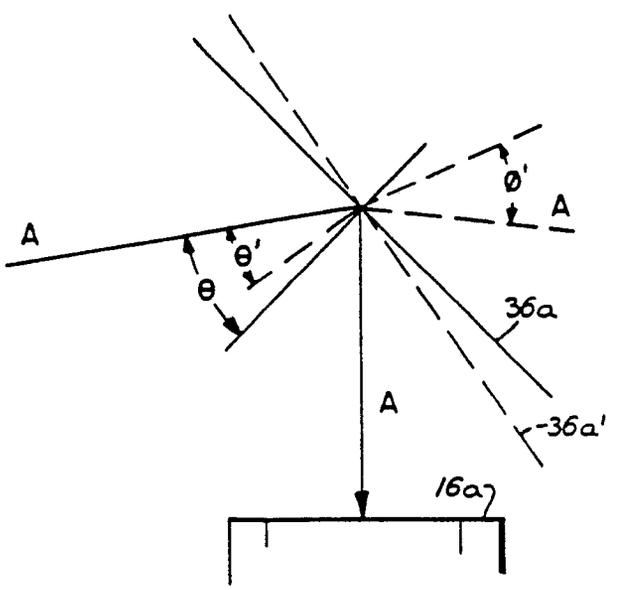



FIG. 6